

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
a first insulating film on a silicon substrate; and
5 a second insulating film on said first insulating film;
wherein said first insulating film is a silicon oxide film
having a film thickness of 1 nm or less and a suboxide content
of 30% or less; and
said second insulating film is a high dielectric constant
10 insulating film.
2. The semiconductor device according to claim 1, wherein
said high dielectric constant insulating film is a metal oxide
film or a metal silicate film.
- 15 3. The semiconductor device according to claim 2, wherein
said metal oxide film is an oxide film of at least one metal
selected from a group consisting of hafnium, zirconium,
lanthanum and yttrium.
- 20 4. The semiconductor device according to claim 2, wherein
said metal silicate film is a silicate film of at least one
metal selected from a group consisting of hafnium, zirconium,
lanthanum, yttrium and aluminum.
- 25 5. The semiconductor device according to claim 4, wherein
said metal silicate film contains nitrogen.
6. A semiconductor device comprising:
30 a first insulating film on a silicon substrate; and
a second insulating film on said first insulating film;
wherein said first insulating film is a silicon oxynitride

film having a film thickness of 1 nm or less and a suboxide content of 30% or less; and

said second insulating film is a high dielectric constant insulating film.

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7. The semiconductor device according to claim 6, wherein said high dielectric constant insulating film is a metal oxide film or a metal silicate film.

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8. The semiconductor device according to claim 7, wherein said metal oxide film is an oxide film of at least one metal selected from a group consisting of hafnium, zirconium, lanthanum and yttrium.

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9. The semiconductor device according to claim 7, wherein said metal silicate film is a silicate film of at least one metal selected from a group consisting of hafnium, zirconium, lanthanum, yttrium and aluminum.

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10. The semiconductor device according to claim 9, wherein said metal silicate film contains nitrogen.

11. A semiconductor device comprising:

a first insulating film on a silicon substrate; and

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a second insulating film on said first insulating film;

wherein said first insulating film is a silicon nitride film having a film thickness of 1 nm or less and an oxygen content of less than 0.1 atom%; and

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said second insulating film is a high dielectric constant insulating film.

12. A method for manufacturing a semiconductor device,

comprising the steps of:

treating a surface of a silicon substrate with a non-oxidizing gas under reduced pressure;

5 forming a first insulating film on said silicon substrate while maintaining said reduced pressure;

forming a metal oxide film on said first insulating film using an oxygen containing material, said metal oxide film being a second insulating film; and

10 heat treating said metal oxide film under an atmosphere of an oxidizing gas.

13. A method for manufacturing a semiconductor device, comprising the steps of:

15 treating a surface of a silicon substrate with a non-oxidizing gas under reduced pressure;

forming a first insulating film on said silicon substrate while maintaining said reduced pressure;

20 forming a metal silicate film on said first insulating film using an oxygen containing material, said metal silicate film being a second insulating film; and

heat treating said metal silicate film under an atmosphere of an oxidizing gas.

25 14. The method for manufacturing a semiconductor device according to claim 13, further comprising a step of:

after said heat treatment, performing a treatment for increasing a nitrogen concentration of a surface of said second insulating film.

30 15. The method for manufacturing a semiconductor device according to claim 14, wherein said treatment for increasing said nitrogen concentration is a heat treatment under an

atmosphere of ammonia gas.

16. The method for manufacturing a semiconductor device according to claim 14, wherein said treatment for increasing
5 said nitrogen concentration is a plasma treatment using nitrogen gas.

17. The method for manufacturing a semiconductor device according to claim 13, wherein said first insulating film is a
10 film selected from a group consisting of a silicon oxide film, a silicon oxynitride film and a silicon nitride film.

18. The method for manufacturing a semiconductor device according to claim 13, wherein:
15 said step of treating said surface of said silicon substrate with said non-oxidizing gas is performed at a temperature between 25 °C and 600 °C; and
said non-oxidizing gas is a fluorine containing gas.

20 19. The method as claimed in claim 13, wherein a partial pressure of said non-oxidizing gas is 100 Pa or less.

20. The method for manufacturing a semiconductor device according to claim 13, wherein:
25 said non-oxidizing gas is a fluorine containing gas; and
said fluorine containing gas is at least one selected from a group consisting of HF, ClF₃, F₂ and NF₃.

21. The method for manufacturing a semiconductor device
30 according to claim 13, wherein said oxidizing gas is oxygen gas.

22. The method for manufacturing a semiconductor device

according to claim 21, wherein said oxygen gas contains ozone or oxygen radicals.

23. The method for manufacturing a semiconductor device
5 according to claim 13, wherein said heat treatment is performed
at a temperature between 100 °C and 400 °C.